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Evaluating hydropyrolysis as a method for quantification and characterisation of Black Carbon in environmental matrices

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Black carbon (BC) is the highly aromatic, recalcitrant product of incomplete biomass and fossil fuel combustion. Black carbon is generally accepted to display extreme environmental longevity, whereas other products of biomass combustion often appear subject to environmental degradation on comparatively short timescales. It is clear that BC plays a key role within global biogeochemical cycles, and improved understanding of BC cycling is an important research goal. Currently a wide selection of thermal, chemical and optical methods are available for BC quantification in environmental matrices, and large method-dependant differences in results are apparent. We present results of a study to evaluate the efficacy of a new approach for BC isolation, known as hydropyrolysis (hypy). In this process sample pyrolysis is assisted by high hydrogen pressures (15 MPa), facilitating complete reductive removal of labile organic matter, while suppressing the neoformation of secondary char. The potential of hypy for both isolation and quantification of BC was evaluated using 12 reference materials of the International BC Ring Trial (http://www.geo.uzh.ch/en/units/physical-geography-soilbio/services/black-carbon-reference-materials/), including high-BC samples, BC-containing environmental matrices and potentially interfering materials. The results show that it is possible to identify hypy operating conditions whereby lignocellulosic, humic and other labile organic carbon is removed, while the sample BC is preserved for recovery. This is apparent for all of the environmental samples tested, facilitating BC quantification in a wide range of materials. The BC contents of all 12 samples are within the range of the inter-comparison study of the International BC Ring Trial, and the technique appears to reproducibly ($\pm$2%) isolate a carbonaceous fraction comprising a chemically well-defined polyaromatic structure from a wide range of different samples. Hypy therefore provides a means of matrix independent BC quantification, with the additional advantage that non-BC sample components are retained with minimal structural rearrangement, for potential further characterisation.